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RESULTS OF A CONE AND SEED INSECT DAMAGE EVALUATION SURVEY IN
SEVERAL DOUGLAS-FIR, WESTERN WHITE PINE AND PONDEROSA PINE SEED
PRODUCTION AREAS, SEED ORCHARDS AND TREE BREEDING AREAS IN
WASHINGTON AND OREGON IN 1964

by

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Insects cause tremendous damage to cones and seeds in the Pacific Northwest Region. Usually, the greatest amount of seed reduction occurs in years when cone crops are small. A recent study by Hedlin in Douglas-fir stands in British Columbia showed that heavy damage can also occur when cones are abundant.^{1/}

Heavy cone crops occur sporadically because of climate and other environmental conditions. In some species, such as Douglas-fir, good crops are produced only every 5-7 years. To supplement the seed supply collected during heavy cone crop years and to increase seed quality, the Forest Service is establishing and maintaining seed production areas and seed orchards. Establishment and maintenance costs of these areas are high. Thus, if insect damage is heavy in seed production areas and seed orchards, their cost-benefit ratio may be unfavorable.

Little is known of the impact of insect-caused damage on total cone crops. It is known that insects greatly reduce the amount of merchantable seed in some areas in some years. Perhaps damage varies both between localities and between years in the same locality.

In the summer of 1964, an evaluation survey was started in seed production areas, tree breeding areas and seed orchards on National Forests in Washington and Oregon to determine:

1. Amount of annual insect-caused damage by species.
2. Variation in damage between localities.
3. Variation in damage between years within the same locality.

^{1/} Hedlin, A. F. A six-year study on Douglas-fir cone insect population fluctuation. Forest Sci. 10(1): 124-28. 1964

METHODS

Plots were established in areas dedicated for production of either Douglas-fir, western white pine or ponderosa pine seeds. Sampling methods were similar for all three species. Five cone-bearing trees in or adjacent to each seed production area, seed orchard or tree breeding area were selected and marked. In total, 20 mature but green cones were collected from each tree--five from each cardinal direction. The object in collecting cones was to select a representative sample regardless of the external appearance of the cones. In some cases, this objective may not have been met.

Cones in all but two areas were collected by National Forest personnel. The Hilltop Seed Production area, Siuslaw National Forest, was sampled by Regional Office personnel from the Insect and Disease Control Branch, Division of Timber Management, in conjunction with a cone and seed insect control administrative study. Cones were also collected from the Island Burn Seed Orchard, Fremont National Forest, by Regional Office personnel.

The 20-cone sample from each tree was placed in a cloth bag and labeled as follows:

- | | |
|--------------------|-------------------------|
| 1. Forest | 5. Collector |
| 2. Ranger District | 6. Tree species |
| 3. Area | 7. Tree number |
| 4. Date collected | 8. Parentage (if known) |

Samples were shipped to the Regional Office in Portland by bus, railway express, air express, parcel post or automobile. Each group of cones was then stored in a refrigerator at the Forest Service's Sellwood Laboratory until mid-September when they were examined by Insect and Disease Control personnel.

Ten cones were selected at random from each 20-cone lot. Each of these ten cones was sliced along its axis using a modified-knife cone cutter. One side of each cone was examined and the following recorded:

- | | |
|------------------------------------|--|
| 1. Cone length | 5. Number of seeds damaged by each insect species per face |
| 2. Cone width | |
| 3. Total seeds per face | 6. Number of insects by species per face |
| 4. Number of filled seeds per face | |

RESULTS

In 1964, 14 plots were established on 13 of the 19 National Forests in Washington and Oregon. Results are reported by tree species.

Care should be taken in interpreting the data in Tables 1, 3, and 5. The "total seeds" column represents the average number of all possible seed per cut face. The "filled seeds" column represents the average number of these seeds that are filled. The difference between these two columns for each area is due to pollination failure and/or cone abortion as well as insect damage. Losses due to the former two causes and insect damage to pollen and male and female flowers were not assessed during this evaluation. Some of the seeds tallied as filled seeds were useless because they were galled by midges and would not extract from the cone scales.

Douglas-fir

Douglas-fir cones were collected from six seed production areas, four in Oregon and two in Washington. Locations of these areas are:

<u>Area name</u>	<u>Ranger District</u>	<u>National Forest</u>
1. Buckhead	Lowell	Willamette
2. Eden Ridge	Powers	Siskiyou
3. Hilltop	Marys Peak	Siuslaw
4. Darrington	Darrington	Mt. Baker
5. Straight Cr.	South Umpqua	Umpqua
6. Satsop	Shelton	Olympic

Cones from all areas except the Hilltop plot were collected and examined according to the previously described methods. To fulfill requirements for another study, 40 cones were collected from each of 10 trees and 20 cones examined.

Cone and seed insect damage varied between plots. West Side Douglas-fir cones must have a minimum sound seed count of 5 per cone face to be considered merchantable during a good seed year.^{2/} Cones from only the Buckhead and Eden Ridge Areas met or exceeded this standard (Table 1). The most predominant insect was the Douglas-fir cone midge, Contarinia oregonensis Foote. Larvae of this pest feed on or near seeds and either directly destroy the seeds or cause galls which fuse them to the scales. Galled seed usually cannot be extracted from the cone. Damage from this insect alone made cones from the Straight Creek, Satsop, and Hilltop Seed Production Areas non-merchantable. Cones from the Eden Ridge Area had over 5 sound seeds per cut face, but at least some of these seeds were probably galled by the midge, thus lowering the value of the cones. Average number of cone midge-damaged seed per cut face ranged from 1.4

^{2/} U. S. Forest Service Handbook on planting and seeding. FSH 2465.5 R6. Nov. 1963

to 6.7 and average number of midges per cut face from 2.1 to 17.9 (table 1). Percent of cones infested with midges ranged from 34-100 (table 2).

Damage by the Douglas-fir seed chalcid, Megastigmus spermotrophus Wachtl. was next in importance to that of the cone midge (table 1.). Each chalcid larva feeds within and destroys a single seed. Average number of seed damaged and insects per cut face ranged from 0.1-1.1. Percent of cones infested with M. spermotrophus ranged from 2-62 with the greatest number of infested cones from Straight Creek and the least from Eden Ridge (table 2). Two to 60 percent of the cones were infested with both the cone midge and the seed chalcid (table 2).

Damage of three other species of Douglas-fir cone and seed insects--the Douglas-fir cone moth, Barbara colfaxiana (Kft.), the fir cone worm, Dioryctria abietivorella (Grote), and the Douglas-fir scale midge, C. washingtonensis Johnson--was detected during this evaluation survey. Damage by only the latter two species was measurable (table 1).

Results from the Buckhead Area were affected by insecticide applications in the spring of 1964. A 1959 field test for control of primarily the Douglas-fir cone midge and the Douglas-fir cone moth was used as a guide.^{3/} In this 1959 study, significant reductions were obtained at two of the tree test areas.^{4/} To determine the effectiveness of spray applications in 1964, twenty cones were collected and sampled from unsprayed trees adjacent to the Buckhead Area. Average total seed per cut face was 15.8 and filled seed 3.7. Both of these figures are less than those obtained from samples of treated cones (table 1). Insects had emerged from the untreated cones before they were examined, so that damage could not be assessed quantitatively. However, cone midge damage was heavy.

It must be noted here that no operational method has been developed for Douglas-fir cone and seed insect control. Materials are presently being tested in British Columbia, Washington, and Oregon. In 1964, an administrative study was made by Weyerhaeuser Company and the Forest Service in the Hilltop Seed Production Area. A single mist blower application of

^{3/} Wright, K. H. and T. E. Greathouse. Work plan--a field test for control of seed and cone insects of Douglas-fir. U.S. Forest Serv., R-6. 1959.

^{4/} Greathouse, T. E., V. E. Allen, and K. H. Wright. Results of a field test to reduce damage to cones and seeds of Douglas-fir. U.S. Forest Serv., R-6, 5 pp. 1960.

the systemic insecticide dimethoate caused a highly significant decrease in both cone midge-damaged seed and midge larvae when applied to recently closed cones.^{5/} However, this material or method of application should not be used on a widespread basis until each is further tested.

Western White Pine

Cones were examined from five areas in the Region--three tree breeding areas, one seed production area, and one seed orchard. Locations of these areas are:

<u>Area Name</u>	<u>Ranger District</u>	<u>National Forest</u>
1. Midway Tree Breeding Area	Randle	Gifford Pinchot
2. Still Creek Tree Breeding Area	Zigzag	Mt. Hood
3. Bear Pass Tree Breeding Area	Sweet Home	Willamette
4. Horse Creek Seed Production Area	Baker	Wallowa-Whitman
5. Jim Creek Seed Orchard	Prospect	Rogue River

Cones were merchantable from all plots except the Bear Pass Tree Breeding Area. Here the filled seed count was less than the required 66-2/3 percent of the total seed count per cut face (table 3).^{6/} High sound seed yields were obtained from the Horse Creek and Midway plots. No insect damage was observed in cones collected from Horse Creek.

At least three different insects caused some damage--the mountain pine cone beetle, Conophthorus monticolae Hopk.--causing the most. This pest kills the second-year cone before it reaches maturity. Damage on only the Bear Pass plot was heavy with an average of 11.1 seed per cut face damaged (table 3). Percent of cones infested on all plots ranged from 0-70 (table 4).

At time of collection, beetle-attacked cones and non-damaged cones were completely dissimilar in appearance--the former being small, brown and dead, and the latter large, green and healthy. Collectors may have chosen either healthy cones or dead cones depending on whether they spotted the insect-damaged ones. In other words, a true sample may not have been obtained.

Larvae of an unknown midge (Itonididae) were recorded at 3 of the 5 areas (table 3). Midges were found in 0-22 percent of the cones examined (table 4). Larvae of a cone moth, probably Eucosma racissoriana Heinrich, infested 6 and 22 percent of the cones at two areas (table 4).

^{5/} Buffam, P. E. and N. E. Johnson. Tests of guthion and dimethoate for Douglas-fir cone midge control. (In process of publication.) 1965.

^{6/} Op. cit. FSH 2465.5 R6.

Ponderosa Pine

Ponderosa pine cones were collected from three areas in the Region, one seed orchard and two seed production areas. Locations of these areas are:

<u>Area Name</u>	<u>Ranger District</u>	<u>National Forest</u>
1. Island Burn Seed Orchard	Drews Valley	Fremont
2. Mission Creek Seed Production Area	Leavenworth	Wenatchee
3. Squaw Creek Seed Production	Sisters	Deschutes

Cones from all three areas were merchantable with the ones from Squaw Creek just barely meeting the minimum requirements (8 sound seed or 50 percent of the total seed sound per cut face).^{7/}

Insect damage was light on the Mission Creek and Island Burn plots and moderate to heavy on the Squaw Creek plot. Pine seed moth larvae of the Laspeyresia-Hedulia complex were the most abundant insects. From 32-92 percent of the cones were infested with this pest, damage ranging from 0.9-5.8 seeds per cut face (tables 5 and 6).

A few specimens of an unknown Itonididae (probably Rübsaamenia keeni Foote) and the ponderosa pine cone beetle, Conophthorus ponderosae Hopk., were also obtained (table 5). Midges were found in cones from 2 of the 3 plots and beetle larvae in cones from one plot. Damage caused by both insects was very light.

MANPOWER REQUIREMENTS

Cone collection required 1-2 man-days of work per plot. In total, 13 man-days were spent examining the cones from all 14 plots.

RECOMMENDATIONS

1. Cones from trees on all 14 plots should be collected and examined again in 1965 and for a total of at least 5 consecutive years. These data should help determine the variation of insect damage between years and between plots in the same year.
2. An effort should be made to record the relative abundance of cones at each plot. If insect damage is heavy when cones are abundant, the impact is greater than if damage is great when cones are scarce.
3. An effort should be made to determine a method for assessing Conophthorus monticolae and C. ponderosae damage to western white pine and ponderosa pine cones, respectively, before the cones are picked. A

^{7/} Ibid.

tree should be closely examined and a ratio of Conophthorus-killed to green cones obtained. Cones should be collected according to this ratio.

4. This evaluation survey should be expanded to include other seed production areas, seed orchards and tree breeding areas as they are established and begin to produce cones.

Table 1.--Summary of cone and seed insect infestations and damage in Douglas-fir cones from six areas in Oregon and Washington ^{1/} in 1964.

Area	:	:	:	:	:	:	:	:	:	:	:	:
	Total	Filled	<u>Contarinia</u>	<u>Megastigmus</u>	<u>Dioryctria</u>	<u>Contarinia</u>	Total seed	Average				
	seeds	seeds	<u>oregonensis</u>	<u>spermotrophus</u>	<u>abietivorella</u>	<u>washingtonensis</u>	damaged by	cone size				
			Seed	Insects	Seed	Seed	Insects	Seed	Insects	Length	Width	
			damaged		damaged	damaged		damaged				
- - - - - Average number per cut face - - - - -												- Inches -
Buckhead	19.4	9.8	1.4	2.1	0.9	--	--	--	--	2.3	2.97	0.96
Eden Ridge	16.7	7.6	6.2	9.6	0.1	--	--	--	--	6.3	2.75	1.02
Hilltop	15.6	3.9	5.1	17.9	0.5	--	--	--	0.2	5.6	2.68	0.91
Darrington	15.3	3.1	1.8	3.7	0.8	0.5	0.1	0.1	0.2	3.2	2.54	0.84
Straight Creek	14.1	3.5	6.7	10.2	1.1	0.5	0.2	--	--	8.3	2.65	0.83
Satsop	11.9	2.2	6.3	8.3	1.1	0.1	0.1	--	0.1	7.5	2.40	0.85

^{1/} All data based on an average of 50 cones per area (10 cones selected from a 20-cone lot collected from each of 5 trees per plot) except for the Hilltop Area where the basis was an average of 200 cones (20 cones selected from a 40-cone lot collected from each of 10 trees).

Table 2.--Percent of Douglas-fir cones infested with Contarinia oregonensis and Megastigmus spermotrophus on six plots in Washington and Oregon in 1964

Area	Cones infested with <u>C. oregonensis</u>	Cones infested with <u>M. spermotrophus</u>	Cones infested with both
	----- Percent -----		
Buckhead	34	32	12
Eden Ridge	100	2	2
Hilltop	94	33	31
Darrington	56	46	34
Straight Creek	98	62	60
Satsop	92	58	56

Table 3.--Summary of cone and seed insect infestations and damage in western white pine cones from five areas in Oregon and Washington in 1964 ^{1/}

Area	Total seeds	Filled seeds	<u>Conophthorus</u>		Miscellaneous		<u>Eucosma</u>		Total seed damaged by insects	Average cone size	
			<u>monticolae</u>		Itonididae		<u>recissoriana</u>			Length	Width
			Seed damaged	Insects	Seed damaged	Insects	Seed damaged	Insects			
- - - - - Average number per cut face - - - - -										- Inches -	
Horse Creek	26.7	23.4	--	--	--	--	--	--	0.0	7.66	1.26
Midway	24.0	22.0	0.4	0.1	0.9	1.8	0.1	0.1	1.4	6.56	1.28
Jim Creek	21.0	15.6	--	--	--	--	--	--	<u>2/</u>	6.26	1.28
Still Creek	19.6	13.2	0.4	0.1	0.7	0.9	--	--	1.1	5.99	1.20
Bear Pass	16.1	4.0	11.1	1.5	--	0.1	0.5	0.2	11.6	3.86	0.86

1/ All data based on an average of 50 cones per area (10 cones selected from a 20-cone lot collected from each of 5 trees per area).

2/ Insect damage could not be assessed because cones were in poor condition when examined.

on five plots in Washington and Oregon in 1964

1/ Unable to assess for insect damage because cones were in poor condition when examined.

Table 5.--Summary of cone and seed insect infestations and damage in ponderosa pine
cones from three areas in Washington and Oregon in 1964 ^{1/}

Area	:	:	:	:	:	:	:	:	:	:	:
	Total	Filled	<u>Laspeyresia</u>	Miscellaneous	<u>Conophthorus</u>	Total seed	Average				
	seeds	seeds	<u>Hedulia spp.</u>	Itonididae	<u>ponderosae</u>	damaged by	cone size				
	:	:	:	:	:	:	:				
:	:	:	Seed	Insects	Seed	Insects	Seed	Insects	:	Length	Width
:	:	:	damaged:	:	damaged:	:	damaged:	:	:	:	:
<hr/>											
<div>- - - - - <u>Average number per cut face</u> - - - - -</div> <div>- <u>Inches</u> -</div>											
Mission Creek	15.0	12.3	1.0	0.5	0.1	0.4	--	--	1.1	3.72	1.95
Island Burn	14.8	11.4	0.9	0.6	0.1	0.3	0.3	--	1.4	3.57	1.77
Squaw Creek	13.5	6.8	5.8	3.3	--	--	--	--	5.8	3.69	2.04

^{1/} All data based on an average of 50 cones per area (10 cones selected from a 20-cone lot collected from each of 5 trees per area).

Table 6.--Percent of ponderosa pine cones infested with
Laspeyresia-Hedulia spp. and miscellaneous Itonididae

on three plots in Oregon and Washington in 1964

Area	: : Cones infested : with : <u>Laspeyresia-</u> : <u>Hedulia</u> spp. :	: : Cones infested : with : misc. Itonididae :
	- - - - <u>Percent</u> - - - -	
Mission Creek	38	8
Island Burn	32	1
Squaw Creek	92	0